ANTARCTICA: PROTOTYPE FOR OUTER SPACE[1]

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ABSTRACT

Because the natural, constructed, and social environments that are found in Antarctica today closely resemble many of those that we expect to encounter in outer space tomorrow, understanding human behavior in Antarctica is important not only in its own right but because it can provide us with insights into the safety, performance, and quality of life of tomorrow's spacefarers. Steps towards increasing the practical benefits and scientific value of behavioral research in Antarctica include involving both behavioral scientists and operational personnel in research planning, and developing research programs that are objective, theory-driven, and sensitive to historical, organizational, and cultural influences. Antarctica may be a particularly useful setting for selecting and training a crew to work on Mars. Although at present there are more opportunities to study people in Antarctica than in outer space, in the long run those who plan, manage, and participate in Antarctic and space programs will benefit from each others' behavioral research.

INTRODUCTION

Antarctica and the Moon have three things in common: They are both hard to reach, they both require artificial life support systems to sustain human presence, and finally, both require staging bases and complex operations for the maintenance of expeditions on the continent" (Hans Mark, Deputy Director of NASA, quoted in Bluth, 1987, p.8).

As laboratories for the study of human behavior, Antarctic environments are of interest both in their own right and because they provide us with excellent opportunities to learn about future life in space. Remoteness, the need for life support systems, and challenges in the areas of logistics and support are only a few of the similarities between Antarctic and outer space environments. Antarctic bases, like future space bases, vary widely in terms

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1. Preparation of this paper was supported by grants from the National Science Fondation (DPP-87-00325) and the National Aeronautics and Space Administration (NCC-2-469). This paper was resented at XXIV International Congress of Psychology, Sydney, September, 1988, and will appear in a volume edited by A. J. W. Taylor and published by the Scott Polar Research Institute, University of Cambridge.

of size, living conditions, crew composition, support needs, and many other variables. Antarctica thus offers us not one but a range of environments, a range encompassing historical trends and varying combinations of conditions that bear strong resemblance to those that we expect in outer space. Since many people have lived in polar regions, but very few people have lived in space, it is convenient to apply findings from groups in polar regions to teams of astronauts and cosmonauts. Thus, studies undertaken in polar regions have figured prominently in discussions of men and women in space (Bluth, 1987; Connors, Harrison & Akins, 1985, 1986; Johnson & Finney, 1986; Palinkas 1987, 1988; Stuster, 1986; Vinograd, 1974).

Behavioral considerations are of interest because they are among the many determinants of mission success and failure. Not only must we prevent major psychiatric episodes that can result in the loss of formerly functioning crewmembers (Bluth, 1987; Santy, 1987; Space Sciences Board, 1987), we must understand the intellectual, emotional, and behavioral reactions that are normally inconsequential but that become critical in demanding and unrelenting settings. For example, psychological factors such as bad judgment, a desire to avoid expending effort, and a lack of respect for danger were responsible when in 1986 U.S. Antarctic personnel deviated from carefully marked paths and took a "short cut" which resulted in them falling to their deaths in a crevasse. Similarly, social pressures to "stay on schedule," wishful thinking, and faulty decision making were among the elements that contributed to the explosion of the Space Shuttle Challenger. It was well known among mission personnel that the O-ring seals in the solid booster rockets could not be expected to function properly given the temperature at the launch site, but the decision to go ahead was made anyway, with the consequent loss of a multi-billion dollar space shuttle and seven lives (McConnell, 1987).

A second, often overlooked reason for studying the psychological and social dimensions of life in isolation and confinement is to go beyond alleviating problems and promote peak performance and morale during the mission and ensure that it will have a positive effect on the subsequent course of the participants' lives (Connors et al., 1985, 1986; Helmreich, 1983; Polar Research Board, 1982; National Science Board, 1987; Space Science Board, 1987). This latter goal becomes salient as we move from a period of initial exploration to a period of firm commitment:

> *Whenever people enter environments that are extreme for them, the principal objective of medical science is to ensure human survival.... However, when what was once experienced by but a few is experienced by many,... the emphasis is on conditions that will facilitate human adjustment, that is, on providing a situation in which a person can expect to be healthy, happy, and effective in family life, work, and community relationships, without crippling emotional symptoms, such as fear, anger, loneliness, envy, or greed. We belive that U.S. development in the high latitudes in the next decades demands this [latter] biomedical*

research strategy (*Polar Research Board, 1982, p.36*).

In space, as in polar regions, we are moving from a period of initial encounter towards in-depth exploration and the creation of semi-permanent or permanent settlements. Recent years have seen the emergence of detailed, practical strategies for future exploration and settlement of space (McKay, 1985a; National Commission, 1986; Welch & Stoker, 1986). These plans call for a phased movement into space, with each step based on the preceding and setting the stage for the next. The first step in the U.S. program was the Shuttle, or national space transportation system. The second step will be the low earth orbit (LEO) Space Station. This will set the stage for a geosynchronous earth orbit (GEO) or "stationary" space station at 22,000 miles, which will in turn facilitate lunar and interplanetary missions.

As our "least inhospitable" neighbor, Mars is the first planet targeted for human vistation. A manned Mars mission is a recognized interest within NASA and has been incorporated into its recent long term Pathfinder program. In 1987, the space agency commissioned a private corporation, Martin Marietta Denver Aerospace, to prepare comprehensive plans for such a mission. The crew is likely to consist of seven to fifteen people. It will involve both men and women and will most likely be multinational, including representatives of the United States, perhaps the Soviet Union, and several other countries. After arriving at Mars, approximately one half of the crew members will remain in orbit, while the remainder visit the surface. Those on the surface will establish a base camp, use land vehicles and airplanes to explore substantial portions of the red planet's surface, and conduct geophysical and life science research. Those who remain in orbit will later visit the surface on a rotational basis. Optimistic projections set the year of departure in the initial decade of the next century (Welch & Stoker, 1986), but years between 2015 and 2035 are also frequently mentioned.

CONTINUITIES BETWEEN ANTARCTICA AND OUTER SPACE

Although, as Dr. Mark's introductory quote suggests, there are certain general similarities between Antarctic and outer space environments, analogies can be sharpened when we pair specific Antarctic environments and historical periods with specific space missions. The habitation of Antarctica is further along than the exploration and settlement of outer space: by choosing wisely, one can find an Antarctic outpost or community today that resembles an outer space outpost or community of tomorrow. For example, the experiences of the early polar explorers (Johnson & Finney, 1986) and winter-over parties at Pole, Siple, and other small research stations are excellent models for initial space expeditions (Bluth, 1987; McKay, 1985b; Stuster, 1986; Vinograd, 1974). Larger Antarctic settlements provide the opportunity to study the kinds of issues that will become salient as the space program enters new phases (McKay, 1985b). McMurdo station, with a population that grows from eighty people during the winter season to well over a thousand people during the summer, is a good model for the transition from isolated group to isolated community, a transition that will occur on the Moon, on Mars, and elsewhere when initial camps are replaced by permanent work bases. McMurdo, especially during the summer season, provides a good opportunity to study the effects of gender, age, and other individual differences on group processes and products. Investigations of these communities could help foster smoother adjustments to the higher population levels that eventually occur in most long-term settlements in outer space (McKay, 1985b) and to deal with such anticipated problems as space tourism.

The Natural Environment

Outer space environments are of two types: orbiting satellites and lunar/planetary bases. As novel, "unworldly," remote, hostile, potentially lethal environments, certain polar regions resemble off-world planetary surfaces. There are strong geological resemblances between the Dry Valley in Antarctica and the surface of Mars. There are meteorological similarities as well.

Antarctica and outer space are dangerous environments. The southern most continent, while mild in comparison to space, is certainly one of the least hospitable places on Earth. Outside of the habitat, special protective clothing is often required in Antarctica, and, for the foreseeable future, always required in outer space. Both environments are improvident in that, at least initially, few (if any) supplies and provisions can be locally produced.

Risk and danger depend not only on the threats inherent in the environment itself, but also upon inhabitants' abilities to minimize or counteract these dangers. The latter reflects not only the physical and intellectual skills of the crew, but also the extent to which the environment is safely engineered, the availability of safety (such as firefighting and medical) equipment, ease of resupply, and accessibility to rescue personnel. Different bases vary in terms of both inherent dangers and users' abilities to counteract them. To the extent that the smaller and more remote Antarctic outposts have less in the way of safety and medical resources and are difficult to reach by rescuers from large, better-equipped bases, they provide closer approximations of the initial Space Station, Moon, and Martian outposts.

The Constructed Environment

Engineering and economic considerations limit the size, design, and provisioning of Antarctic and outer space habitats. If the dwelling has to be dragged across miles of ice by tractors, air-lifted into the interior of Antarctica, or blasted into orbit, it must be a compact if not cramped construction. Additionally, requirements for high structural integrity and life support systems result in the loss of weight and interior space that could be devoted to work, living, and recreational activities. Also for engineering and economic reasons, life proceeds without abundant equipment, provisions, or supplies. Both the amount of supplies and equipment that can be transported to the site and the amount of storage space are limited. Resupply may be extremely expensive, dangerous, or impossible. Even simple amenities and luxuries may be absent. For example, fresh foods are likely to be very hard to get because of transporation and storage problems, and they are not likely to be produced on site due to a combination of technical barriers and legislation intended to protect local ecologies. Limited personal hygiene facilities are common concerns; both Antarctic and spaceflight personnel have complained about the lack of toilets and water for personal hygiene (Bluth, 1987; Oberg & Oberg, 1986).

The Social Environment

Antarctic and outer space microsocieties consist of pre-selected people who are brought in from the "outside," and who are neither helped nor hindered by native populations. Both Antarctica and outer space are characterized by isolation and confinement. Isolation refers to being cut off from outside contact; confinement refers to the opportunity to evade one's co-adventurers. The severity of isolation and confinement can be assessed along two dimensions: degree and duration.

Degree of isolation depends upon such variables as distance from civilization or the home community (perhaps better measured in terms of travel time than miles), frequency of visitations by "outsiders," and ease of radio and television communication with home. Degree of confinement depends upon such such variables as interior space, number of confinees, opportunities to escape surveillance (for example, by retreating to individual sleeping quarters), and opportunities to temporarily leave the habitat for work or recreational purposes. Duration in either case refers to the length of the stay.

Again the degree of correspondence between Antarctic and outer space environments depends upon our selection of environments and measures. In terms of physical distances from home, Antarctica and the Space Station are "right next door" compared to the Moon base which is in turn nearby relative to Mars. Generally speaking, we can expect less confinement in Antarctica than in outer space. In Antarctica, interior floor space is likely to be generous relative to the crew size, especially after the "tourists" depart for the winter. In both settings, there will be opportunities to leave the habitat, but in space this may be restricted to work-related purposes. In both Antarctic and outer space locations mission duration is highly variable: three months for summer personnel in Antarctica, nine to thirteen months for U.S. winter-over personnel (including adjacent summer seasons), and two years or so for British Antarctic personnel (Bluth, 1987). Because of the expense associated with personnel rotation, Space Station crews are likely to spend a minimum of three months in space, and Moon base crews a minimum of six months. Interplanetary missions are likely to take a minimum of three years, and, in the absence of a major breakthrough in the area of propulsion, interstellar travel will be reckoned in generations (Finney & Jones, 1985).

Space crews have been evolving in the direction of increased size. The earliest space missions, which involved single individuals, gave way to missions involving crews of two and three. Current Russian crews involve groups of three, and U.S. Shuttle crews have included as many as seven astronauts. Eight or ten people are likely to staff the Space Station, and, depending upon the scenario, the initial Mars mission will involve seven to fifteen spacefarers. Space Stations, Moon Bases and Mars Bases will be of modular construction, with the result that they will eventually house scores or possibly hundreds of people. Eventually, huge orbiting colonies and interstellar migrations may involve tens or hundreds of thousands of people (Finney & Jones, 1985).

Antarctica, of course, provides an excellent opportunity to study groups of different sizes, ranging from large crews at main stations during the summer months to small crews at remote stations during the winter. In addition to comparing crews of different sizes at one point in time, it is possible to conduct longitudinal studies as, at a given location, small crews make the transition into large crews and large crews become communities. The same general growth patterns that are occurring in Antarctica can be expected to occur in future off-world locations (McKay, 1985b).

Another major change in space crew parameters is towards increasing heterogeneity of crew composition. Specifically, whereas the initial astronauts were youthful, white male test pilots from military backgrounds, the spacefarers of today and tomorrow represent different ethnic groups, both sexes, a range of ages, and a diversity of professions and interests. Heterogeneity will further increase as more and more missions are performed by international crews. Once more we can find parallels in Antarctica. Whereas the earliest polar exploration teams tended to consist of very similar people, today we can find groups whose members represent both genders and a variety of socioeconomic, educational, and cultural backgrounds. Here, too, we can go beyond static comparisons and explore the actual change process. There are many important questions regarding male-female, interethnic, and international mixes, questions having to do with differing preferences and aversions, overcoming language barriers, and the like.

Deployment and Continuous Presence

As Philip Harris (1986) has pointed out, missions involve series of events. He suggests that "deployment" or sending a group to any remote setting involves four sequential phases. In chronological order, these are (1) attraction and selection; (2) training; (3) on-site support; and (4) re-entry into the home community. The overall success of a continuing program depends upon satisfactorily dealing with each element within this sequence. In other words, there are many critical steps that precede either an antarctic or outer space mission, and a thorough analysis requires consideration of "precursors and postscripts" as well as the mission proper.

If we expand our focus beyond a narrow span of time, we discover that Antarctica also provides an excellent model for "continuous presence" (McKay, 1985). Although any individual's tour of Antarctica or of outer space is likely to be limited, when we consider successive tours we find a series of interconnected, overlapping missions. Stations in Antarctica have been continuously inhabited by a succession of crews for thirty years, a testimony to the viability of continued presence in hostile environments. The goal of continued human presence is also a major factor in plans for the exploration and settlement of space. While some upcoming space expeditions will involve transient crews, the structure and planning of future missions will require long-term planning and management to build and maintain stable, permanent populations.

Organizational and Societal Contexts

Both polar and outer space missions involve off-site as well as on-site personnel, and to understand crew behavior we have to take support teams into account. Governmental funds are allocated to specific agencies which in turn plan and manage Antarctic and space missions. Agency headquarters --- located substantial distances from the mission's site --- set mission goals and assemble the necessary materiel and staff. Once the mission is underway, these agencies use radio and other means to retain control over on-going operations, sometimes down to the day-to-day or even hour-to-hour level. Although off-site and on-site personnel can be viewed as parts of a larger team, there are many interesting questions regarding relationships between these two components. It is not always clear that each contingent is able to understand the others' perspective, that those at headquarters are fully aware of the difficulties of living and working on-site, or that operational personnel are fully sensitive to the political and legal pressures that act upon headquarters.

In both settings, mission personnel are separated from their immediate families. Whereas many have pondered the impact of separation upon the mission participants, less attention has been directed towards understanding the reciprocal impact of separation on families. Separation tends to have an adverse impact on spouses and children, and reunification can create a second set of problems (Polar Research Board, 1982; Space Science Board, 1987). Family-participant relationships are important in their own right, and because anticipated or experienced conflict with family members could affect a crewmember's performance during the mission and willingness to volunteer for subsequent service.

Finally, considering context in the most general sense, there is good reason to consider the impact of missions on society at large. Participants' behavior influences public confidence in and support for Antarctic and outer space programs. Accidents, low levels of productivity, and behavior that is inconsistent with society's values can create an unfavorable impression and the withdrawl of public support (Harrison, 1986).

IMPROVING BEHAVIORAL RESEARCH

There have been many recent calls for increased study of men and women in isolation and confinement (Brady, 1985; Christensen & Talbot, 1985; Connors et al., 1985, 1986; Helmreich, 1983; Nicholas, 1985; Santy, 1987) including calls from influential scientific advisory panels. A primary conclusion of a Polar Research Board (1982) study of biomedical and sociocultural issues was that, in polar regions, sociocultural factors, as compared to strictly medical factors, were responsible for a disproportionate number of human problems. The Board set, as the highest priority in the social sciences, research dealing with those factors that contribute to a positive "quality of life" in polar regions. More recently, the Committee on the National Science Foundation's Role in Polar Regions noted that Antarctica "provides a natural laboratory for studying the impact of extreme conditions on individual and collective behavior," that such understanding will promote "safety, productivity, and quality of life in polar and analagous environments," and that "the NSF has an opportunity, as... manager of the U.S. Antarctic Program, to foster greater awareness and increased efforts in social and behavioral sciences research" (National Science Board, 1987, pp. 40-41). Concurrently, the Committee on Space Biology and Medicine of the Space Science Board noted that:

> *Although the evidence is fragmentary, it seems likely that behavioral and social problems have already occurred during long-term missions and that such problems will become exacerbated as missions become more complex, as mission duration is increased, and as the composition of crews becomes more heterogeneous. An understanding of the problems and their amelioration is essential if man desires to occupy space for extended periods of time. Even more important from a scientific perspective, it seems likely that significant advances in our basic knowledge of human interaction and group processes will emerge from the research needed to ensure effective performance and adjustment in space ' (Space Science Board, 1987, p.169).*

The Space Science Board went on to acknowledge the value of Ground Based Models based on research conducted in laboratories and such "fully operational situations as underseas habitats, submarines, and polar stations" (Space Science Board, 1987, p.169). In 1987, the Division of Polar Programs of the National Science Foundation and the National Aeronautics and Space Administration co-sponsored a conference entitled The Human Experience in Antarctica: Applications to Life in Space, intended to increase psychological, social psychological, and organizational research in polar, outer space, and analagous settings, and to promote the application of useful findings. Additional efforts are underway to promote cooperative NSF-NASA research.

Increasing Rewards for Research Participation

Operational personnel do not always find behavioral research to be in their best interests (Harrison, 1986). Mission managers may be put in an uncomfortable position if the results somehow reflect poorly on their judgment or leadership skills. Also, recommendations might be forthcoming that reduce managerial discretion. For example, because logistical constraints may severely limit crew size relative to the amount of work that needs to be done, twelve hour work shifts may seem attractive. However, there is less latitude to assign such shifts if behavioral research suggests that crewmembers should work no more than eight hours a day. Also, there is always the possibility that results could challenge participants' images as tough and resourceful people or draw attention to sexual activity, substance abuse, or similar controversial behaviors. This can lead to bad publicity and possible funding cuts. Perhaps it is for reasons such as these that some suspect an underreporting of the frequency and severity of behavioral problems in Antarctica (Bluth, 1987) and space (Space Science Board, 1987).

There are several strategies for reducing apprehensions and increasing the benefits that stem from participation in behavioral research (Harrison, 1986). These include frank reassessments of goals and procedures on the part of researchers, and educational programs aimed at participants. Also useful is to involve both operational personnel and behavioral scientists in the research planning process. Whereas experienced polar workers may have first-hand knowledge of the Antarctic environment and a good sense of behavioral issues, they may lack the training required to conduct high quality behavioral research. Trained behavioral scientists, on the other hand, may have little or no understanding of the realities of Antarctic life. Joint participation of researchers and operational personnel in the planning process should foster rapport and understanding, promote the identification and prioritization of researchproblems, and encourage the development of workable and effective methods. Cooperative planning involving researchers and operational personnel was a major theme of the Human Experience in Antarctica: Applications to Life in Space conference.

Increasing Scientific Dividends

Whatever the political, military and economic considerations that prompt us, scientific advancement remains a primary justification for the human presence in Antarctica of space. Behavioral and social scientific research in these locations provides additional scientific justification for each program. For maximum benefit, we have to make sure that the behavioral science is good science. There are several strategies for achieving these ends (Harrison & Connors, 1984; Harrison, 1987).

First, we need to increase the objectivity of behavioral and social research. Much of the data that we have accrued regarding life in isolation and confinement is based on case histories, unrepresentative samples, and attitudinal measures. Research programs that are based on good-sized, representative samples, employ control groups, and utilize quantitative measures of actual behavior would provide firmer evidence on the effects of isolation and confinement and enhance the credibility of behavioral research.

Second, we need to ncrease the theoretical relevance of this type of research. Theories serve useful purposes both in terms of guiding research and in terms of explaining and integrating findings. Two theories which are highly promising for studying men and women in isolation and confinement are living systems theory as developed by James Grier Miller and his associates (Miller, 1978) and the "programmed environment" framework developed by Joseph V. Brady and Henry Emurian (Brady & Emurian, 1983).

Third, we need to broaden our perspective to include temporal and historical trends and the larger social contexts within which missions proceed. As already noted, both polar and space missions involve sequences of events (selection, training, on-site support, re-entry), and we would profit from continuing longitudinal studies which encompass the "precursors and postscripts" as well as the mission proper. Also as noted, missions are complex systems that involve family members, sponsoring agencies, and the society at large, each of which needs to be taken into account.

Understanding people in isolation and confinement is thus an interdisciplinary exercise requiring the attention of psychologists, psychiatrists, sociologists, anthropologists and other professionals whose primary interest is people.

ANTARCTICA: TESTING GROUND FOR MARS?

Behavioral research in Antarctica could be of particular benefit to the Mars mission. The time line is a good one: unlike the Space Station, the Mars mission is not slated too soon for a carefully planned, large scale research program to bear fruit, and unlike interstellar migration it is not so far away as to seem meaningless. Also, the degree of correspondence between Antarctica and Mars is particularly close. Unlike the Space Station, the Mars mission involves a surface base, and Antarctic geography more closely approximates that of Mars than that of the Moon. Certainly there has been abundant experience in Antarctica with Mars-sized crews of seven to fifteen people. In both locations, scientific personnel are prominent and have similar research strategies and goals. For example, the first Mars astronauts will erect a home base and then establish satellite camps to conduct research in geoscience, atmospheric science, and life science (Welch & Stoker, 1986).

Antarctica provides the opportunity for testing structures, supplies, and equipment as well as people, a fact that has not gone unnoticed by U.S. aerospace and architectural firms. Of interest to both polar and space enthusiasts would be small, compact, transportable research stations. Another area of mutual interest is the design of equipment that will perform reliably under trying conditions, and training programs for those who will operate and repair the equipment. There is also the opportunity to study supplies. This involves not only the usual need assessments, but also surveys of consumer acceptance and mechanisms for inventory control.

Antarctica can contribute to space operations as well as space-related research. Antarctic bases could serve as useful assessment centers, that is, locations for comprehensive personnel selection procedures involving interviews, psychological testing, and performance testing by a variety of evaluators. Training astronauts for Mars demands not only high-quality simulators, but also spaceflight-analagous environments and space itself. Antarctic training sites would preserve many of the features associated with Mars bases, but would be less costly to operate than training sites in space. Antarctica could be the second or intermediate step in a three step selection and training process which would begin in simulators at home and end aboard the Space Station. Antarctic bases offer certain advantages over simulators at agency headquarters. In Antarctica, the sheer distance from home should make the training involving and realistic, and whereas the trainee in the U.S. or Russia knows that he or she can always terminate the experiment by walking out through the door, it is not so easy to quit in Antarctica. And, of course, Antarctica offers the best terrestrial approximation of the Martian surface (McKay, 1985b).

If we can't find a suitable Antarctic training base, we can build one. This would allow us to duplicate as many Marsflight conditions as possible. The base could be geared to Mars crew size and composition, and, if research or training missions could not last as long as the entire Mars mission, they could last as long as the stay on the planetary surface. Such a base would provide us with the opportunity to study a full range of deployment issues at the individual, small group, organizational, and societal levels.

CONCLUDING OBSERVATIONS

From the perspective of those whose primary interest is outer space, Antarctica is an excellent site for building our understanding of reactions to isolation and confinement, and improving the interfaces among environments and people. Because of the variability in Antarctica, it provides us with a useful prototype for a whole array of space missions. From the perspective of those whose primary interest is Antarctica, polar behavioral research is important in its own right, because it can be put to immediate use improving safety, performance, and quality of life. Right now, there are more opportunities to study people who are living and working in Antarctica than there are to study people living and working in space, but, in the long run, those who plan, manage, and participate in polar and outer space expeditions can profit from each others' research and findings.

The emphasis has been on the similarities among carefully chosen Antarctic and outer space locations. Of course there are also some important dissimilarities, even in the case of carefully paired environments. For example, the weightlessness associated with the Space Station and the .48 normal Earth gravity associated with Mars are not duplicated in Antarctica. Whereas at times only minimal protective clothing is required in Antarctica, this is not the case in space where the unmodified atmosphere does not sustain human life. Due to the expense of lifting mass into orbit, even Pole and Siple seem spacious relative to the initial off-world outposts. At smaller bases such as Siple, Pole and Palmer it is possible to have emergency camps or "safe havens" and to store five years' worth of supplies in case war or other factors render Antarctica inaccessible. We cannot expect such margins of safety in outer space. The three to five years expected for a Mars mission is substantially longer than duty periods in Antarctica, although some experienced winter over personnel have expressed an interest in five year tours (Bluth, 1987).

In one recent study, Stuster (1986) examined the correspondence between a number of isolated environments including Antarctic environments and compared them with the Space Station as then envisioned. Approximately fifty experts rated thirteen environments along fourteen dimensions, including duration of tour, hostility of outside environment, perceived risk, psychological isolation, quality of life support, and physical quality of habitat. Stuster found that after actual spaceflight environments (Skylab IV), the underseas research environments, submarines, and then Antarctic research stations provided the best overall analogs. Antarctica placed in the top five analogs in terms of composition of group, hostility of environment, work activities, physical isolation, and quality of habitat. However, Stuster's research may have understated the value of Antarctica, because his point of reference, the Space Station, does not involve surface exploration. However exact or inexact the correspondence, Antarctica remains very attractive to space psychologists because it provides more opportunity for research than today's underseas and outer space settings.

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Footnote

1. This research was supported in part by by grants from the National Science Foundation and the National Aeronautics and Space Administration.